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Relationship of susceptibility and growth stages of plant for development of epidemic of sheath blight in rice

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Abstract: The present paper deals with most susceptible growth stage of rice with different farms and quantitiy of inoculum for development of sheath blight of rice by *Rhizoctonia solani*.Among seven different growth stages of rice crop *i.e.* seedling, initial tillering, maximum tillering, boot leaf, panicle emergence, flowering and dough stage, the flowering stage was found to be most susceptible and highly prone for sheath blight development, while seedling stage was found to be least susceptible and with low proneness for disease development. Disease severity, number and length of lesions get increased with the increasing crop growth stages up to flowering stage and thereafter disease severity decreases with the increases in further growth stages of rice plant. Among four different growth stages of the pathogen (inoculum capacity) *i.e.* five days old mycelium, seven days old mycelium, milky sclerotial stage and mature sclerotial stage which were inoculated at maximum tillering stage of rice plants, five days old mycelial inoculum was found to be most virulent. Disease severity decreased and incubation period increased with further ageing of inoculum. Among five different amount of inoculum (inoculum density) *i.e.* 0.20 mg, 5.50 mg, 6.00 mg, 7.00 mg and 8.00 mg of sclerotial inoculum, which were inoculated at maximum tillering stage of rice plants, highest disease severity and minimum incubation period was observed with 8.00 mg amount of sclerotial inoculum. Whereas, least disease severity and longest incubation period was observed when inoculation was done with 0.2 mg of sclerotial inoculum.

Keywords: Crop growth stages, Inoculum capacity, Inoculum density, Epidemics

INTRODUCTION

Rice (*Oryza sativa* L.) is the staple food for more than 70% of the world population. In India, area under rice cultivation during the last 50 years has increased only by one and half times (from 30 million ha to about 45 million hectares), but its productivity has been enhanced to nearly triple (from 7.00 q/ha, to 20.00 q/ha) and even then it is still very low in comparison to world average productivity *i.e.* 39.65 q/ha (Mishra, 2004). At the current rate of population growth of 1.8%, the rice requirement for the Indian Nation is estimated to be around 140 million tones by 2020 (Dwivedi, 2004).. Achieving this target in the next one decades, without harming the environment, is a grate challenge. To meet the growing food needs of increasing population in the country and more so in the state of Uttar Pradesh, there is a need to raise rice productivity in the region.

There are several productivity constraints for rice production like biotic and abiotic factors, which cause annual loss to the tune of 12 to 25 per cent of the total production. Among biotic factors, several diseases like Bacterial leaf blight, Blast, Brown leaf spot and Sheath blight are major ones. Among these diseases, sheath blight caused by *Rhizoctonia solani* Kuhn, which was earlier considered to be a minor disease is now regarded as internationally important and most damaging disease. Now it is second only to and often rivals of blast disease. Management of any disease mostly depends upon the complete knowledge of epidemiology. While performing epidemiological studies, inoculation techniques become very important factor. Potential of any inoculation technique mostly depends on the age and amount of inoculum and growth stage of host plant as well. Present study was therefore undertaken to investigate the effect of factors related to host as well as pathogen both. These factors include plant growth stages,and quality and quantity of inoculum on disease development. This study may be helpful for succesful development of epidemic of sheath blight in rice.

MATERIALS AND METHODS

All the experiments were conducted in net house, of the

Department of Plant Pathology at Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P.) for two kharif season i.e.2005 and 2006 during August to November, in completely randomized block design. The seeds were sown in the month of July to raise the nursery for transplanting in pots. Effect of seven crop growth stages of rice varitiy Pusa basmati-1 on disease development were tested with four replications. Seven growth stages of the crop included seedling stage, initial tillering stage, maximum tillering stage, boot leaf stage , panicle emergence stage, flowering stage and dough stage. Seed sowing was done on 18th july and transplanting was performed on 11th August in both the years. With the similar set of experimental materials, two other experiments were also conducted to observe the effect of inoculum capacity and inoculum density of pathogen (fungal) on the severity of the disease.

Effect of inoculum capacity : Four different growth stages of pathogen *i.e*. approximately 5 mg disc of five days old mycelium, seven days old mycelium, milky sclerotial stage and mature sclerotial stage were used as primary inoculum from the culture grown on potato dextrose agar medium. Inoculation was done at maximum tillering stages. Procedures of inoculation and observations for this experiment were done in the similar manner as in preceding experiment on crop growth stages.

Effect of inoculum density: Different quantity (weight) of mature sclerotia *i.e.* 0.20 mg, 5.50 mg, 6.00 mg, 7.00 mg and 8.00 mg were used as primary inoculum from the culture grown on potato dextrose agar medium. Inoculation was done at maximum tillering stage. Procedures of inoculation and observations for this experiment were done in the similar manner as in preceding experiment on crop growth stages.

Raising crop nursery: Healthy seeds of highly susceptible rice variety, *i.e*. Pusa Basmati-1(In severe infection upto 70% severity of disease occures) were soaked overnight in water and then surface sterilized by dipping in (2%) sodium hypochloride solution for ten minutes and thereafter washed thrice with sterilized distilled water, and dried in shade for 6 hrs. These seeds were sown by brodcasting in nursery plot on 17th July in both years. Twenty five day old seedlings were uprooted and transplanted in pots (15 cm diameter) containing soil amended with appropriate amount of FYM and N.P.K. in form of Urea, Single super phosphate and Murate of Potash, respectively. At the time of transplanting three seedlings were transplanted in one hill and each pot contained three hills.

Inoculation: Inoculation was done using sheath inoculation method (Singh *et al.,* 2002) in which sheath of only the second fully expended leaf (from top) were inoculated at all the test stages during the experiment on different crop growth stages, for inoculation, leaf sheath were opened carefully and a five mm mycelial disc containing milky sclerotia was placed inside the sheath, where as in the experiment where different stage of pathogen's growth or amount of sclerotial inoculum were to be tested, either 5mm disc of different test stage or different test weight of fungal sclerotia were inoculated. Inoculation with either mycelial disc or sclerotia was done by simply placing inoculum inside leaf sheath wethout making any injury. A few drop of sterilized distilled water was added to the inoculated sheath and wrapped with absorbent moist cotton to provide constant moisture. Inoculation was done in the evening and plants were sprayed with water every morning and evening to provide sufficient moisture to pathogen for performing its pathogenic activity well, because in field, dence crop canopy and high moisture content favours severe disease development. Inoculated plants were regularly examined for symptoms appearance. The size of lesions were measured daily, after inoculation till fifth day after symptoms expression. The number of lesion were counted after 3 days and upto 15 days after symptoms expression.

Appraisal of sheath blight severity: The disease severity was recorded with the help of inoculated plants in each replications. Two plants were taken from one replication for recording disease severity in terms of relative lesion

Table 1. Relationship of different stages of rice plant with sheath blight.

Crop growth stages	Incubation period (hours)	No. of lesions at 15 days	Lesion length at 5 days (cm)	Disease severity/RLH (%)
Seedling stage	114	2	1.40	18.52 (25.22)
Initial tillering	102	3	1.80	30.56 (33.53)
Maximum tillering	72	4	2.10	55.56 (48.23)
Boot leaf stage	51	6	3.00	69.45 (56.67)
Panicle emergence stage	42	7	3.20	88.56 (70.23)
Flowering stage	39	8	3.40	92.23 (73.88)
Dough stage	48	5	2.80	77.78 (62.28)
C D at 5%	**10.175**	**0.550**	**0.240**	**7.292**

Figures given in parenthesis or angular transformed value.

Table 2. Relationship of fungal growth stages with sheath blight development in rice.

Stages of inoculum	Incubation period (hours)	No. of lesions at 15 days	Lesion length at 5 day (cm)	Disease severity/ RLH (%)
Five days old mycelium	39	6	3.1	83.34 (66.2)
Seven days old mycelium	48	5	2.5	80.54 (64.04)
Milky sclerotia stage	54	3	2.2	66.67 (54.88)
Mature sclerotial stage	72	2	2.0	55.54 (48.23)
C.D. at 5 %	**8.439**	**0.629**	**0.422**	**7.80**

Figures given in parenthesis or angular transformed value

height (RLH). These randomly selected plants were tagged for identification. RLH was recorded at 5 days interval after symptom appearance, throughout the investigation period. Lesion length and number of lesions of sheath blight were also measured in cm with the help of plastic scale. RLH was measured using following formula:

$$\text{Relative lesion height (RLH)} = \frac{\text{Lesion length}}{\text{Plant height}} \times 100$$

RESULTS AND DISCUSSION

Among seven crop growth stages, inoculation of the rice platns at flowering stage, resulted in maximum disease severity and comparatively shorter, rather minimum incubation period followed by inoculation at panicle initiation stage, dough stage, boot leaf stage, maximum tillering stage, minimum tillering stage and seedling stage, respectively. Maximum number and length of lesions were also recorded in the plants inoculated at flowering stage. Inoculation of rice plants at seedling stage resulted in longest incubation period and least disease severity. Thus it seems that flowering stage of plant is more susceptible and highly prone for sheath blight development whereas seedling stage seems to be, comparatively less susceptible with low proneness.

Singh *et al.* (2002) also observed that susceptibility of rice plants to sheath blight disease initially increases with increasing growth stage of crop with maximum susceptibility recorded at soft dough stage. Thereafter susceptibility decreases with the increase in further growth stages of plants, Munshi and Singh (2000) reported that *R. solani* was able to infect rice plants at seedling, tillering and flowering stages. However, the disease severity was lowest (59.7%) at seedling stage and maximum (93.3%) when inoculated at flowering stage. It took shorter incubation period to develop lesions at flowering stage than at seedling and tillering stage. Dubey and Toppo (1997) found that susceptibility to the sheath blight, initially increased with the increasing age of rice plants. Thereafter, susceptibility decreased with the increase in age of plants. Kozaka (1961) found that young leaf sheath or blades when 2-3 weeks old, are more resistant than when they are 5-6 weeks old. Before the heading stage, the upper leaf sheaths and blades are more resistant than the lower ones, but after the heading stage, the susceptibility of the upper parts increase with increasing plant age. The findings of present investigation is quite in conformity with findings of earlier workers like, Munshi and Singh (2000), Kozaka (1961) and Dubey and Toppo (1997).

Among the various stages of inoculum, inoculation of rice plants with five days old mycelium resulted in minimum incubation period, highest number and length of lesions and highest disease severity, followed by 7 days old mycelium, milky sclerotial stage and matture sclerotial stage. It was found that there was gradual decrease in the number and length of lesions and disease severity, where as incubation period was gradualy increased with increasing age of inoculum. Gradual loss of virulence and aggressiveness due to less release of chemical weapons like various pathogenic enzymes and toxines, with increasing age of inoculum may be the possible reason behind such findings.

Sharma and Singh (2003) reported that youngest mycelium (4 days) resulted in shortest incubation period and largest lesions length at 96 hrs after incubation followed by immature and mature sclerotia inoculated at the maximum tillering stage. But in case of number of lesions, Sharma and Singh reported youngest mycelium resulted in slow multiplication rate of lesions, at earlier stage, while during present investigation the lesion multiplication rate was also high when 5 day old mycelium was used for inoculation, although the differences were non-significant. Other findings of present investigation like incubation period and lesion length etc. are on the similar line of the findings of Sharma and Singh (2003).

Among different amount of inoculum, 8.0 mg of sclerotial inoculum resulted in minimum incubation period, maximum disease severity, and highest number and length of lesions. It was also noticed that with gradually increasing the amount of sclerotial inoculum, there was increase in the number, and length of lesion and level of disease severity, while the trend of incubation period was in decreasing order. Thus it is clear that there is positive correlation between the inoculum density and disease

Table 3. Relationship of inoculum density with number of lesions and incubation period.

Inoculum density (weight of sclerotia mg)	Incubation period (hours)	No of lesions at 15 days	Lesion length at 5 days (cm)	Disease severity/RLH (%)
0.20	102	2	1.7	38.53 (38.53)
5.50	63	2	2.0	47.21 (43.36)
6.00	54	3	2.2	50.00 (44.99)
7.00	45	4	3.0	63.88 (53.24)
8.00	39	5	3.5	69.45 (56.52)
CD at 5%	**11.872**	**0.778**	**0.413**	**7.426**

Figures given in parenthesis or angular transformed value

severity.

Sharma and Singh (2003), reported that the size of sclerotia affects not only the incubation period but also the number and size of lesions after inoculation. Incubation period decreased with increases in mass of sclerotia, while the number and size of lesions increases. Basu and Gupta (1992) found positive correlation between the size of sclerotia (In terms of actual weight of indevidual sclerotia) and pathogenicity.

According to Dasgupta (1992), size of sclerotia was found to be directly correlated with inoculum potential. Bigger sclerotium resulted in higher disease severity. Dodman and Flentje (1970) observed that very less amount i.e. less than 50 µg propogules are generally non-pathogenic to rice seedlings. With findings of present investigation and from earlier literature reviewed it is now clear that the size of sclerotia, amount of sclerotia or even amount of mycelial inoculum are deciding factors in the pathogenicity and aggressiveness of *Rhizoctonia solani*. Findings of present investigation is confirmed and being supportive to the findings of earlier workers. From present findings it can be concluded that for experiments on artificial inoculation and creation of epiphytotic conditions , the proper stage of rice plants for inoculation should be at flowering stage ,whereas the inoculum should be five days old mycelial stage and if sclerotial inoculum are to be used for inoculation, the quantity of sclerotia should be >8.00 mg. On the basis of present findings, in future, proper care should be taken by doing fungicidal spray at flowering stage of rice crop which is most susceptible crop stage.

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